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Book of Abstracts
November 2-5, 1998

Kellie Ann Beall, Editor

Building and Fire Research Laboratory
Gaithersburg, Maryland 20899

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U.S. Department of Commerce
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Thermal Sensors for Evaluating Firefighter Protective Clothing

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Abstract

The Center for Research on Textile Protection and Comfort (T-PACC) at North Carolina State University (NCSU) has conducted research which had, as its primary objective, the selection and evaluation of sensors that can be used to measure heat transferred through firefighter protective clothing materials. This paper will describe the comparative performance of these sensors in exposures to intense sources.

A review of state-of-the-art thermal sensor technologies led to the identification and selection of sensors that are currently used for evaluating materials for firefighting applications. Each of the candidate sensors was tested and comparatively evaluated based on a set of performance requirements for thermal sensors used for materials testing, or for thermal measurements in firefighting environments. Laboratory experiments were conducted to characterize sensor response to different levels of heat exposure and to evaluate the accuracy of the thermal measurements. Also, a burn model was developed to determine tolerance times for each exposure condition.

Instrument studies successfully identify critical differences in sensor performance that provides a useful basis for selecting the optimum sensor for this application.

The NCSU insulated copper sensor is demonstrated to be a reliable and versatile thermal sensor for applications related to evaluating the thermal protective performance of firefighter's protective clothing. Laboratory tests indicate that the insulated copper sensor provides a consistent and stable reading over the wide range thermal exposures of interest in this application. They show that the insulated copper sensor registers heat flux much like the TPP calorimeter, a device with a long history of use in bench scale testing of thermally protective materials. At the same time, the insulated copper sensor is packaged in a smaller and far less bulky housing than is required to insulate the TPP calorimeter against heat loss. The insulated copper sensor has the additional advantage of possessing a small mass in comparison to the TPP calorimeter (1.3 grams vs. 17.9 grams). This is an important consideration, since the small mass of the insulated copper sensor should significantly reduce heat sink effects associated with the use of the TPP calorimeter. This should contribute to improve the accuracy of the bench top TPP tests when used in sample mounting configurations that require intimate contact between the thermal sensor and the test fabric.

Although the sensors that utilize relatively insulative materials with surface mounted thermocouples and embedded thermocouples, perform comparatively well in thermal tests, they lack the durability in use that can be expected from the insulated copper device. Most significantly, the insulated copper sensor overcomes a significant drawback associated with this type of sensor: it does not require an inverse heat transfer calculation to estimate heat flux. This avoids errors associated with thermocouple location, and the mathematics of the heat transfer calculations. Direct heat flux measurements, using the insulated copper sensor, circumvent these errors and provide a more accurate direct reading.